SCENARIO ESTIMATES OF RARE EARTH RECYCLING POTENTIALS FROM NDFEB MAGNET MATERIAL

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Rare earth element (REE) containing neodymium-iron-boron (NdFeB) magnets play a major role in green technologies, which largely constitute efficient motor and generator applications. Examples include wind turbines, hybrid and electric cars and bicycles, and other efficient motor and generator applications used in industrial, domestic and other infrastructure contexts. Potential geopolitical supply risks for neodymium and dysprosium, the main rare earth elements used in these magnets, have been a topic for discussion in recent years. Recycling, substitution at material and component level, and efficient use of critical rare earths have been discussed as strategies to mitigate rare earth metal criticality felt outside China, the main rare earth producing country. Substitution for heavy rare earths, the most critical REEs for use in NdFeB magnets, has been the strategy largely followed by companies outside China. Recycling is being discussed as the main alternative strategy, and has been a focus of research activities in recent years. Recycling activities for pre-consumer scrap are starting to become economically viable, while recycling of end-of-life magnets is only at research or pilot scale level. However, besides phosphors used in energy efficient lighting, NdFeB magnets constitute one of the most interesting source materials of secondary rare earths. Here, we present our detailed and comprehensive estimates of global recycling potentials from EOL magnets from 11 different NdFeB application groups and industrial scraps from NdFeB production until 2030, quantified through a dynamic material flow analysis study. Recycling potentials for REEs used in NdFeB magnets, namely neodymium (Nd), praseodymium (Pr), terbium (Tb) and dysprosium (Dy), were calculated for years 2020-2030, derived from two demand scenarios to reflect uncertainties in historic NdFeB demand figures and future demand development. A detailed review of the literature was performed to obtain qualitative and quantitative data for NdFeB demand in 11 application groups, and complemented with expert opinions. These were provided by magnet manufacturers and other industry experts. Literature sources included peer-reviewed publications, corporate and other sources. Information on market trends for applications using NdFeB in individual application groups, on technology trends for NdFeB magnet applications and available alternatives on a component (motor) and (magnet) material level was compiled. Latest technological trends in magnet manufacturing, i.e. of heavy rare earth content reduction efforts, and their effects on both the demand for individual rare earths and the composition of EOL magnet material and industrial scraps are taken into account. In order to derive REE recycling potentials from NdFeB / REE demand scenario estimates, information on product lifetimes, existing collection rates for individual applications and observations regarding potential disassembly efforts were considered. Assumptions regarding losses during the actual recycling processes were based on information from life cycle assessment studies (Sprecher et al., 2014; Walachowicz et al., 2014). The most important NdFeB application groups in terms of recycling potentials were identified. Scenario estimates for the respective percentages of heavy and light rare earth demand which can be met via recycling in years 2020-30 will be presented. The results will be of interest to players in the field of rare earth recycling, and researchers working in the fields of urban mining and sustainable resource utilization. They are currently being used for a follow-on scenario LCA study to estimate environmental impacts from rare earth primary production which can be avoided by NdFeB recycling.

References

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